

Influences of N Fertilizers on the Vegetable Amaranth Production

Somchai Chakhatrakan

Department of Agricultural Technology, Faculty of Science and Technology,
Thammasat University (Rangsit Campus),
Pathum Thani, 12120, Thailand

Abstract

The effects of N fertilizer applications to the vegetable amaranth growth and yield were studied on the filed experimental plots located at Thammasat University, Pathum Thani, Thailand in 2001. Different rates and timings of N application were tested under Factorial Completely Randomized Design with four replications. Fertilizers were applied at 0, 125.0, 187.5, 250.0 and 312.5 kg ha⁻¹, with application timings at 1) pre-plant and 7 days after sowing; 2) pre-plant and 14 days after sowing; and 3) at 7 and 14 days after sowing. Significant differences in plant height, stem diameter, number of leaves, and plant fresh weight were observed among all treatments. The vegetable amaranth with N at 312.5 kg ha⁻¹ at 7 days after sowing produced the highest yield.

Keyword: amaranth, nitrogen, plant fresh weight

1. Introduction

Amaranths are annual tropical plants in the Amaranthaceae family. Amaranths are seen as cereal crops, vegetable crops, ornamental plants, and weed plants. Amaranths widely grown for vegetable crop is called *Amaranthus tricolor* and originated from Southeast Asia. The protein content in dry amaranth was 27% higher than several vegetables. Additionally, amaranth contains high Ca, Fe, and vitamin C and several nutritional elements [1]. In Thailand, amaranth is commonly cooked for humans and freshly fed to animals. Wittayakorn reported that amaranth was used as an herbal supplement to reduce fever, phlegm, and to clean the bladder. Farmers should consider planting amaranth agronomically and domestically. Study on the N fertilizer demand of amaranth is essential to recommend an appropriate N rate for amaranth production in the future.

2. Materials and Methods

The experimental design of this study was Factorial Completely Randomized Design consisting of N fertilizer rates and application timings. Five N application rates and three application timings were studied. The total of 15 treatments were tested with three replicates for each treatment.

1. Timings of N application are as follows:

- a. Pre-plant application and 7 days after sowing
 - b. Pre-plant application and 14 days after sowing
 - c. 7 days and 14 days after sowing
2. Nitrogen fertilizer rates are as follows:
- a. 0 kg N ha⁻¹ (control)
 - b. 125.0 kg N ha⁻¹
 - c. 187.5 kg N ha⁻¹
 - d. 250.0 kg N ha⁻¹
 - e. 312.5 kg N ha⁻¹

2.1 Methods

The amaranth was planted in 35 cm-diameter clay pots. One hundred kilograms per hectare of P and K fertilizers were mixed well with the top 10 cm of soil at the surface of each pot for all treatments one day prior to the planting date. Twenty amaranth seeds were sown under 1 cm depth soil in each pot. All pots were irrigated with 300 ml of water two times daily. Additional N fertilizers (46-0-0) at each rate of treatment were applied by mixing with the water application during a growing season. At 14 days after sowing, plants were removed to remain ten plants per pot. Physical control was used as a weed management method whenever it was necessary.

Stem and leaf growths were recorded at 14 days after sowing and continued at every four

days throughout the growing season. Leaf color pigment intensity was measured at harvesting time using a color pigment intensity measuring instrument (Minolta SPAD-502). Fresh and dry weights of the whole plant were measured. Plants were oven-dried at 80 C for 48 hrs.

3. Results:

3.1 Stem and Leaf Growths

Plant height was significantly different among all treatments influenced by N fertilizer rates and timings of N application. The highest plant height was recorded from the treatment with preplant fertilizer and N application at 7 days after sowing at 312.5 kg ha⁻¹, followed by 250.0, 187.5, 125.0, and 0 kg N ha⁻¹, respectively. Similar results were observed in the plant stem diameter and the number of leaves per plant. Plant supplied with 312.5 kg N ha⁻¹ at 7 and 14 days after sowing produced significantly more leaf color pigment intensity than those supplied with 250.0, 187.5, and 125.0 kg N ha⁻¹, respectively.

3.2 Root Growth

Plant root was harvested at 25 days after sowing. Root characteristics showed significant differences among all treatments influenced by N fertilizer rates and application timings. Highest root length, root fresh weight and root dry weight were recorded from treatment with preplant fertilizer and N application at 7 days after sowing at 312.5 kg N ha⁻¹, followed by 250.0, 187.5, 125.5, and 0 kg N ha⁻¹, respectively.

3.3 Yield

Plant fresh and dry weights were recorded at 25 days after sowing and were different among all treatments influenced by N fertilizer rates and application timings. Highest plant fresh weight and plant dry weight were recorded from the treatment with preplant fertilizer and N application at 7 days after sowing at 312.5 kg N ha⁻¹, followed by 250.0, 187.5, 125.0, and 0 kg N ha⁻¹, respectively.

Table 1. Vegetable amaranth plant height (cm) and stem diameter (cm) influenced by different N rates at various application timings

| Timing of N application | height (cm) | | | | | diameter (cm) | | | | |
|-------------------------------|---------------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------------|--------------------------------|--------------------------------|---------------------------------|--------------------------------|
| | N applications (kg ha ⁻¹) | | | | | N applications (kg ha ⁻¹) | | | | |
| | 0 | 125.0 | 187.5 | 250.0 | 312.5 | 0 | 125.0 | 187.5 | 250.0 | 312.5 |
| Preplant+7 days after sowing | ^c 1.18 ^d | ^a 19.85 ^c | ^a 24.80 ^b | ^a 28.08 ^a | ^a 29.49 ^a | - | ^a 0.53 ^c | ^a 0.68 ^b | ^a 0.72 ^{ab} | ^a 0.76 ^a |
| Preplant+14 days after sowing | ^c 1.18 ^d | ^a 18.82 ^c | ^a 23.37 ^b | ^a 26.71 ^a | ^a 28.69 ^a | - | ^a 0.51 ^c | ^a 0.68 ^b | ^a 0.69 ^{ab} | ^a 0.70 ^a |
| 7 & 14 days after sowing | ^c 1.18 ^d | ^a 16.34 ^c | ^b 20.35 ^b | ^b 21.79 ^a | ^b 22.65 ^a | - | ^b 0.38 ^c | ^b 0.38 ^c | ^a 0.49 ^{ab} | ^b 0.58 ^a |

Different letters of pre and post superscripts present significant differences at p=0.01 for N application timings and N application rates, respectively, by Duncan's Multiple Range Test comparison (DMRT).

Table 2. Vegetable amaranth plant leaf (number) and leaf colors (SPAD unit) influenced by different N rates at various application timings

| Timing of N application | plant leaf (number) | | | | | leaf color (SPAD) | | | | |
|-------------------------------|---------------------------------------|--------------------------------|---------------------------------|---------------------------------|--------------------------------|---------------------------------------|---------------------------------|---------------------------------|---------------------------------|---------------------------------|
| | N applications (kg ha ⁻¹) | | | | | N applications (kg ha ⁻¹) | | | | |
| | 0 | 125.0 | 187.5 | 250.0 | 312.5 | 0 | 125.0 | 187.5 | 250.0 | 312.5 |
| Preplant+7 days after sowing | - | ^a 7.53 ^b | ^a 8.43 ^{ab} | ^a 8.47 ^{ab} | ^a 9.33 ^a | - | ^c 14.94 ^d | ^c 18.89 ^c | ^c 21.44 ^b | ^c 23.96 ^a |
| Preplant+14 days after sowing | - | ^a 6.90 ^b | ^a 8.20 ^{ab} | ^a 8.33 ^{ab} | ^a 8.77 ^a | - | ^b 19.47 ^d | ^b 22.08 ^c | ^b 23.79 ^b | ^b 27.94 ^a |
| 7 & 14 days after sowing | - | ^b 5.57 ^b | ^b 6.00 ^{ab} | ^b 6.10 ^{ab} | ^b 6.23 ^a | - | ^a 20.10 ^d | ^a 26.33 ^c | ^a 28.83 ^b | ^a 29.67 ^a |

Different letters of pre and post superscripts present significant differences at $p=0.01$ for N application timings and N application rates, respectively, by Duncan's Multiple Range Test comparison (DMRT).

Table 3. Vegetable amaranth root lengths (cm) influenced by different N rates at various application timings

| Timing of N application | root length (cm) | | | | |
|-------------------------------|---------------------------------------|--------------------------------|---------------------------------|---------------------------------|--------------------------------|
| | N applications (kg ha ⁻¹) | | | | |
| | 0 | 125.0 | 187.5 | 250.0 | 312.5 |
| Preplant+7 days after sowing | ^c 0.01 ^c | ^a 4.43 ^b | ^a 5.11 ^{ab} | ^a 5.38 ^{ab} | ^a 5.85 ^a |
| Preplant+14 days after sowing | ^c 0.01 ^c | ^a 2.46 ^b | ^a 3.32 ^{ab} | ^a 4.23 ^{ab} | ^a 5.62 ^a |
| 7 & 14 days after sowing | ^c 0.01 ^c | ^b 1.52 ^b | ^b 2.16 ^{ab} | ^b 2.29 ^{ab} | ^b 2.47 ^a |

Different letters of pre and post superscripts present significant differences at $p=0.01$ for N application timings and N application rates, respectively, by Duncan's Multiple Range Test comparison (DMRT).

Table 4. Vegetable amaranth root fresh and dry weights (grams) influenced by different N rates at various application timings

| Timing of N application | root fresh weight (gram) | | | | | root dry weight (gram) | | | | |
|-------------------------------|---------------------------------------|--------------------------------|---------------------------------|---|--------------------------------|---------------------------------------|--------------------------------|---------------------------------|---------------------------------|--------------------------------|
| | N applications (kg ha ⁻¹) | | | | | N applications (kg ha ⁻¹) | | | | |
| | 0 | 125.0 | 187.5 | 250.0 | 312.5 | 0 | 125.0 | 187.5 | 250.0 | 312.5 |
| Preplant+7 days after sowing | ^c 0.01 ^c | ^a 4.43 ^b | ^a 5.11 ^{ab} | ^a 5.38 ^a _b | ^a 5.85 ^a | ^c 0.001 ^c | ^a 0.40 ^b | ^a 0.52 ^{ab} | ^a 0.54 ^{ab} | ^a 0.62 ^a |
| Preplant+14 days after sowing | ^c 0.01 ^c | ^a 2.46 ^b | ^a 3.32 ^{ab} | ^a 4.23 ^a _b | ^a 5.62 ^a | ^c 0.001 ^c | ^a 0.23 ^b | ^a 0.40 ^{ab} | ^a 0.50 ^{ab} | ^a 0.57 ^a |
| 7 & 14 days after sowing | ^c 0.01 ^c | ^b 1.52 ^b | ^b 2.16 ^{ab} | ^b 2.29 ^a _b | ^b 2.47 ^a | ^c 0.001 ^c | ^b 0.15 ^b | ^b 0.20 ^{ab} | ^b 0.25 ^{ab} | ^b 0.26 ^a |

Different letters of pre and post superscripts present significant differences at $p=0.01$ for N application timings and N application rates, respectively, by Duncan's Multiple Range Test comparison (DMRT).

Table 5. Vegetable amaranth plant fresh and dry weights influenced by different N rates at various application timings

| Timing of N application | plant fresh weight (gram) | | | | | plant dry weight (gram) | | | | |
|-------------------------------|---------------------------------------|--------------------------------|--------------------------------|--------------------------------|--------------------------------|---------------------------------------|--------------------------------|---------------------------------|---------------------------------|--------------------------------|
| | N applications (kg ha ⁻¹) | | | | | N applications (kg ha ⁻¹) | | | | |
| | 0 | 125.0 | 187.5 | 250.0 | 312.5 | 0 | 125.0 | 187.5 | 250.0 | 312.5 |
| Preplant+7 days after sowing | ^d 0.008 ^d | ^a 1.60 ^c | ^a 2.71 ^b | ^a 4.40 ^a | ^a 5.03 ^a | ^c 0.003 ^d | ^a 0.21 ^c | ^a 0.36 ^{bc} | ^a 0.52 ^{ab} | ^a 0.61 ^a |
| Preplant+14 days after sowing | ^d 0.008 ^d | ^b 1.50 ^c | ^b 2.58 ^b | ^b 3.90 ^a | ^b 4.52 ^a | ^c 0.003 ^d | ^a 0.20 ^c | ^a 0.34 ^{bc} | ^a 0.39 ^{ab} | ^a 0.56 ^a |
| 7 & 14 days after sowing | ^d 0.008 ^d | ^c 0.65 ^c | ^c 1.31 ^b | ^c 1.73 ^a | ^c 2.40 ^a | ^c 0.003 ^d | ^b 0.10 ^c | ^b 0.12 ^{bc} | ^b 0.17 ^{ab} | ^b 0.20 ^a |

Different letters of pre and post superscripts present significant differences at $p=0.01$ for N application timings and N application rates, respectively, by Duncan's Multiple Range Test comparison (DMRT).

4. Discussion

Different rates and timings of N application to vegetable amaranth were evaluated in this experiment. Fertilizers were applied at 0, 125.0, 187.5, and 250.0 kg ha⁻¹ with application timings at 1) pre-plant and 7 days after sowing; 2) pre-plant and 14 days after sowing; and 3) at 7 and 14 days after sowing. At 7 days after sowing, amaranth successfully utilized N fertilizer more than applying N at other times, since plants at this stage are able to take up N available in the soil via their root system. One of the reasons why the N application at 7 days after sowing gave the best result for amaranth production is that the amaranth root begins to germinate at 2-4 days after sowing. Therefore, the 7 day old seeding is the most active in using the N fertilizer as compared with the 14 days old seeding because the food storage in the amaranth seed is probably used up at about 7 days after sowing. [5]

The recommendation of N fertilizer rate for amaranth is generally at 93.8-125.0 kg ha⁻¹ [4]. This study used low organic matter soil and therefore higher N rates up to 312.5 kg ha⁻¹ can stimulate higher growth and yield. It can be inferred that amaranth is an N sensitive plant because the yield is stimulated with increasing of N application.

5. Conclusion

1. Timings of N application influenced amaranth production greatly. The recommended timing of N fertilizer application is at 7 days after sowing.
2. Recommended nitrogen application rate under low organic matter soil is 312.5 kg ha⁻¹.

6. Acknowledgements

This study had been funded by the Faculty of Science and Technology, Thammasat University. The author would like to thank Assoc. Prof. Dr. Boonhong Chongkid who gave assistance in reviewing the author's English writing, Miss Yosita Rudeekit who prepared the paper printing, and the Department of Agricultural Technology, Thammasat University which provided all facilities for this research.

7. Reference

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